Sensor Research and Development Corporation

Surface Acoustic Wave Mercury Vapor Sensor

Technology Need:

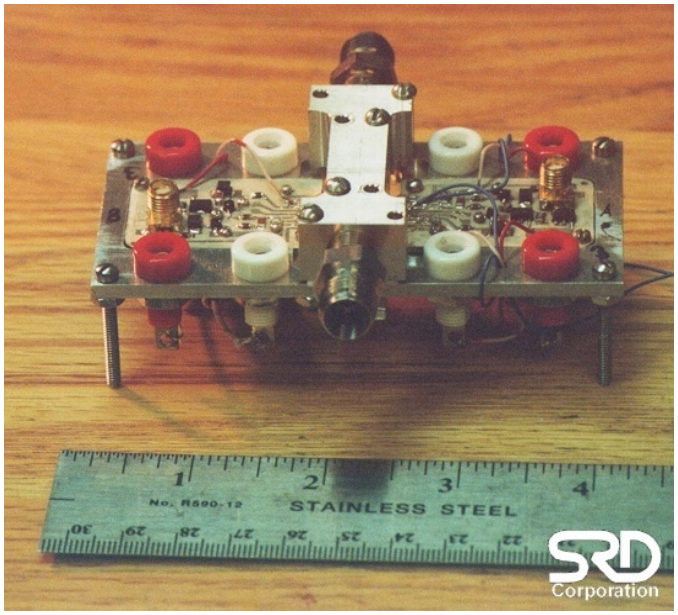
The US Department of Energy (DOE) is developing thermal processes for treating hazardous mixed wastes. These thermal treatment systems emit trace amounts of metals into the atmosphere. Of all the metals contained in these emissions, mercury is of the greatest concern since it is highly mobile, very toxic, and the most volatile of the metals. It has long-term persistence in the environment and can bioaccumulate within the food chain and lead to irreversible neurological disorders and other health related problems.

Continuous Emissions Monitors (CEMs) for mercury will be required to demonstrate the effectiveness of mercury control methods, such as mercury filters, and to enable the real-time process control of these thermal treatment systems. Monitoring of mercury in off-gases is a crucial need that will facilitate the licensing and permitting of mixed waste treatment systems. New technology must be developed which is less expensive, simpler to maintain and operate, and more robust.

Technology Description:

Sensor Research and Development Corporation (SRD) is developing a fast, inexpensive, reliable, and very sensitive in-situ sensor instrument for detecting and monitoring vaporized mercury. This sensor will be capable of detecting extremely low (< 200 ppb) levels of mercury vapor, will be field deployable, and will provide continuous data on either cumulative mercury exposure or instantaneous concentration.

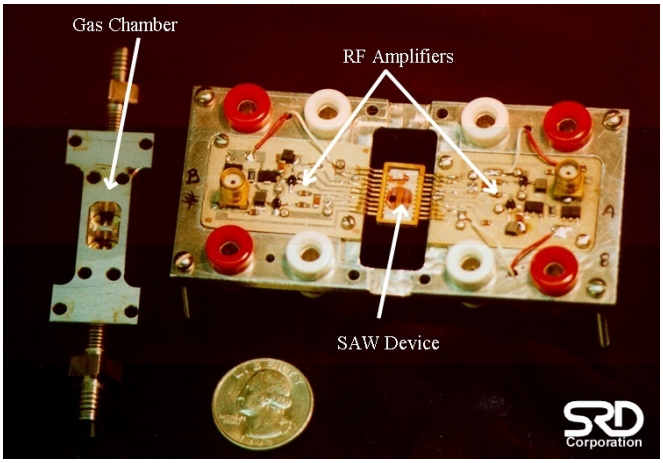
SRD's prototype instrument utilizes a surface acoustic wave (SAW) microsensor which employs a gold film as a sensing element to detect mercury vapor. The careful integration of chemiresistive and SAW technology has the potential to provide a small, low-power, portable, inexpensive and accurate means of monitoring mercury



vapor over a wide concentration range (sub-ppb to ppm levels). The selectivity of the sensor is embodied in the gold film while the sensitivity is in the SAW device.

Upon exposure to mercury vapor, the film conductivity (resistivity) and mass change as a function of mercury concentration. The SAW device monitors the film changes and outputs a frequency which is a direct measure of the mercury concentration.

Through the development of other selective films, this sensor technology is extendible to the selective detection of other metal contaminants (e.g. Mercury (Hg), Cadmium (Cd), Uranium (U)), gaseous pollutants such as hydrogen sulfide (H_2S), oxides of nitrogen (NO_x), sulfur oxides (SO_x) and ammonia (NH_3), and volatile organic compounds (VOC's) which are extremely important because they have all been associated with a host of harmful medical and biological problems in humans, animals and plants.



Benefits:

▸Continuous, real-time, autonomous operation

▸Substantial net cost advantage over competing technologies (estimated at < $2,000/ unit)

▸Predictable, reliable performance with little or no maintenance requirements when deployed

▸Highly sensitive to mercury vapor over a broad range of concentrations

▸Simple, rugged design with low power requirement, portability and in situ operation

▸Adaptable as either CEM, process control instrument, fixed remote site monitor, or portable site characterization instrument

Status and Accomplishments:

In Phase I, SRD worked to determine the optimum chemiresistive film operating temperature and then to design, fabricate, and test the SAW mercury-sensing element. The phase culminated with an analysis of test results performed to determine if the proposed sensing element is feasible for a thermal treatment process control instrument (which the test did indicate).

During Phase II, bench-scale demonstration testing of the prototype was completed at the University of North Dakota Energy and Environmental Research Center (UNDEERC). The CEM was very sensitive to elemental mercury and nearly as sensitive to mercuric compounds when tested with a simulated combustion gas stream devoid of acid gases (mainly SO2 and HCl). When these constituents were added to the gas stream, fairly rapid poisoning of the SAW gold film was experienced.

To circumvent this problem, SRD integrated their instrument with the sampling and preconditioning system under development at UNDEERC to remove acid gases and water vapor from the sample stream. Even with the preconditioner, the gas stream was not clean enough for the SAW sensors to survive direct continuous contact even for a short period. Since EM site needs have decreased in priority for mercury emissions monitoring since this project's inception, continued development was not pursued by DOE. The project was completed on March 31, 2002.

Contacts:

George P. Miller
Sensor Research and Development Corporation
Phone: (207) 866-0100
E-mail: gmiller@srdcorp.com

Ronald K. Staubly
National Energy Technology Laboratory
Phone: (304) 285-4991
E-mail: ron.staubly@netl.doe.gov

Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 2170
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

For additional information, please visit SRD's website at http://www.srdcorp.com